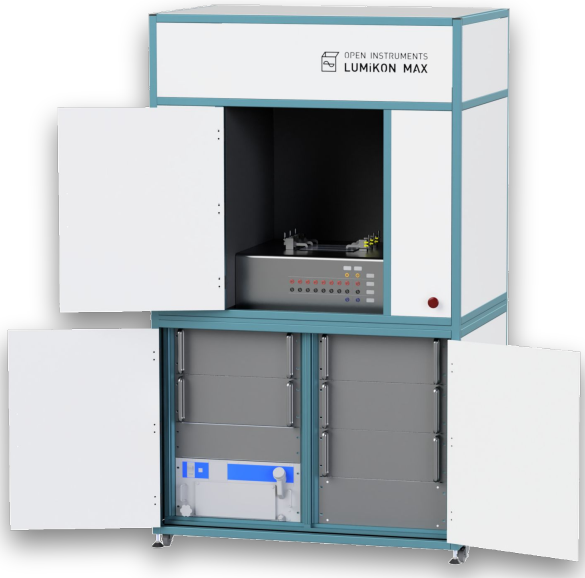
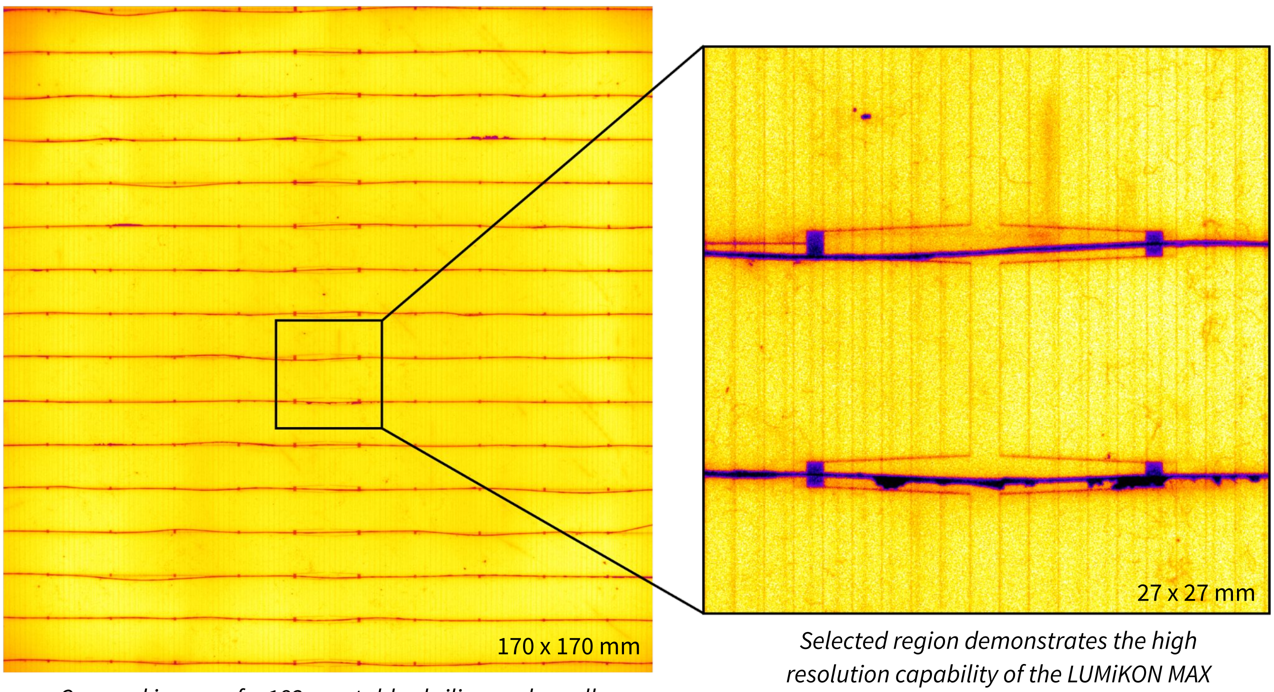
LUMiKON MAX

High resolution photoluminescence imaging system for perovskite, silicon, and perovskite-silicon tandem solar cells and wafers

LUMiKON MAX is our feature-rich flagship system, combining decades of experience in photovoltaic characterization. It is specifically designed for testing of full size perovskite, silicon, and perovskite-silicon tandem solar cells, of 210 mm x 210 mm or larger. Key electrical and optical parameters can be measured as a function of time, temperature, and/or injection level.

The system was developed in collaboration with leading researchers in PL imaging at the University of New South Wales (UNSW) and Helmholtz-Zentrum Berlin (HZB) to ensure that the system achieves state-of-the-art performance in the areas that matter most.





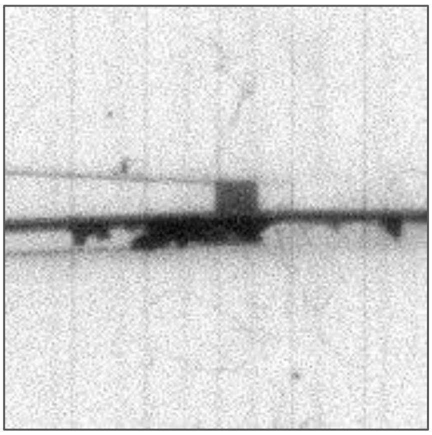
Cropped image of a 182 mm tabbed silicon solar cell

Selected region demonstrates the high resolution capability of the LUMiKON MAX

Standard Features

- **Ultra-high resolution images**
  Imaging microscopic defects on a full size solar cell requires exceptionally high-performance cameras and objectives to achieve the necessary optical resolution. Open Instruments has invested significant resources into identifying the optimal camera and objective combinations, leading to images with clarity that far exceeds the competition. LUMiKON MAX produces high-dynamic range 16-bit images with up to 40MP, and can resolve features down to 65 µm in size.

Incumbent competitor



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- **Automatic system optimisation and auto-focus**
  LUMiKON MAX automatically adjusts focus and camera settings to ensure consistently sharp and high-contrast images with optimal exposure. This enables even inexperienced users to capture perfect PL and iVoc images, eliminating the need for manual focus adjustments due to changes in substrate thickness or PL emission wavelength.
- **Automated generation of implied voltage images (iVoc)**
  We have eliminated the guesswork in interpreting and processing PL images. The vast majority of photovoltaic researchers are interested in the lifetime-linked implied voltage, making calibrated iVoc images critical to their work. LUMiKON MAX effortlessly generates these images for you.
- **Full control of illumination enables iFF, iMPP, and pseudo-JV**
  Optical biasing of each individual junction in a tandem cell requires independent control of each light source. Our system provides continuous variation of irradiance from 0.01 to 1.20 Suns equivalent photon flux (assuming 100% EQE), and allows for arbitrary mixing of the two sources. This enables automated imaging of the implied fill factor (iFF), implied maximum power point (iMPP), and pseudo-JV curves.
- **Future-proofed algorithms**
  Our software offers an easy-to-use, recipe-based automation to study cell performance as a function of time, temperature, irradiance, and current injection. In addition, we provide a Python scripting interface that enables users to include new image processing algorithms developed by researchers.

Optional Features

- **Full PL spectrum at selected points**
  In some cases, it is necessary to measure the full wavelength spectrum to extract compositional information. LUMiKON MAX allows users to click on a pixel in the PL image and obtain the full PL spectrum, along with the calculated bandgap energy. Whilst we offer full hyperspectral imaging as an option, point measurement is a cost-effective alternative that most researchers find sufficient.
- **Temperature controlled chuck**
  We offer a thermoelectric chuck with the ability to set the sample's temperature between +5°C and +85° C. Temperature can be controlled via the standard recipe-based automation to enable easy measurement of cell performance as a function of temperature.
- **EL imaging, I-V measurement, and electrical contacting**
  For electrical characterization, we offer a 4-quadrant source measure unit (SMU) for IV measurement and electrical biasing of PL (EL) images. Along with the SMU, we provide a measurement chuck for electrical contacting. If required, we can also supply embedded custom contacting schemes for IBC cells.

Specifications

Material compatibility	Perovskites, silicon, or others emitting from 600 to 1000 nm
Sample size	210 mm x 210 mm, or larger on request
PL / EL imaging modes	iVoc, iFF, iMPP, pseudo-JV, raw PL/EL
Image calibration	Factory calibrated for absolute irradiance in µW/cm²
Image resolution (3 versions)	95 µm for 210 mm x 210 mm FOV, 65 µm for 210 mm x 210 mm FOV or 95 µm for 210 mm x 210 mm FOV and zoom in to 15 µm for 25 mm x 25mm FOV
Image format	4176 x 4176 (17 MP), 16-bit TIFF, pixel binning optional
Illumination source	445 nm / 100 W and 915 nm / 150 W fiber-coupled diode lasers
Illumination control	0.01 to 1.2 Suns equivalent photon flux, independent for each laser
Illumination uniformity	+/-5% over the sample plane
Sample temperature *	+5°C to +85°C
EL biasing *	Four quadrant, ±30 A, ±10 V, constant voltage or current precision: ±1m V, ±30 mA with sub-100 ms settling time
Spectral point scanning *	550-1000 nm and/or 1000-1700 nm, selectable for any image pixel
Hyperspectral imaging *	Fast full-area imaging with 550-1000 nm spectral range
Automation	Recipe-based system for automatic measurement sequences
Custom algorithms	User-defined Python image processing functions
Input power	110-240 VAC +/- 10%, 1.8 kW
Dimensions	117 cm x 197 cm x 84.5 cm (W x H x D)
Weight	285 kg
Compliance	EN60950-1, EN60824-1, and EU Machinery Directive 2006/42/EC

** Optional upgrade*

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